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Plant Host Sequence of Major Cotton Insects in Southern Arizona

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February 1975

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Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
In Cooperation With
Arizona Agricultural Experiment Station

PLANT HOST SEQUENCE OF MAJOR COTTON INSECTS
IN SOUTHERN ARIZONA

By R. E. Fye [1]

INTRODUCTION

Many injurious and beneficial insects overwinter in London rocket (*Sisymbrium irio* L.), a common weed on disturbed land in Arizona. The insects then move to desert vegetation and alfalfa and, subsequently, to early grain sorghum, cotton, and pigweed (*Amaranthus* spp.), and, finally, to late-grain sorghum. The predators feed upon softbodied insects, mainly aphids, and move when the food supply becomes limited. The sequence offers a potential manipulable system for suppressing the pest species.

Increased study of insect populations for pest management indicates that several segments of pest populations, which may occupy the same agricultural area at the same time, should be approached and studied as a complete ecosystem.

Graham and Robertson (10), [2] Graham et al. (9), and Cole et al. (3) described the seasonal abundance and plants upon which the *Heliothis* complex occurred in the Rio Grande Valley of Texas. Schuster et al. (13) described the host plants of the cotton leafhopper in the Rio Grande Valley. Shiller et al. (14) listed the host plants of the pink bollworm, other than the genus *Gossypium*, in southern Arizona. Stoner (16) listed the species of cotton insects occuring on *Sphaeralcea* in southern Arizona. Fye et al. (8) noted the seasonal abundance of insects in cotton fields in southern Arizona. Fye (6) reviewed the cotton pest and predator reservoirs in the Avra Valley in southern Arizona.

Alternate hosts of the *Heliothis* complex (2, 3, 9) and the pink bollworm (14) have been determined previously, and the pest and predator reservoirs in southern Arizona (6, 8, 16) have been ascertained.

The studies discussed in this report were carried out between 1968 and 1973 to determine (1) the abundance of cotton insects in alternate crop and weed hosts, (2) the extent of the segments of populations of cotton insects present in alternate sources, (3) the feasibility of forcing the movement of the beneficial insects into cropping areas, and (4) ways of minimizing pest populations in wild hosts. These studies were made in the Avra Valley and other agricultural areas in south central Arizona and in the Yuma area.

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[2] Underscored numbers in parentheses refer to Literature Cited, p.8.

INSECT SURVEY METHODS

Cotton and sorghum insects in the several surveys were assessed by direct inspection of the plants. From 100 to 500 plants were examined on each date, depending on the type of survey, the size of the plants, and the area involved. The counts were converted to density per acre by determining the mean numbers of plants in a given length of row at some time during the growing season and calculating the density per acre. From these data, the number of insects per acre was projected.

Insects in the small grain and rangeland were surveyed by direct inspection, utilizing 1-yd^2 or 0.5-m^2 quadrats. The resulting insect counts were projected to density, utilizing the proper conversion factors.

Weeds and alfalfa were surveyed with the sweep net. Fifty or more sweeps per field were made on several occasions, and the conversion to density was made, utilizing a predetermined estimate of the area covered by each sweep (5 ft^2). Generally, the weeds did not provide a continuous ground cover, and the sweeps in sporadic stands were continued over bare ground so the inconsistent density of the weed cover would be properly projected.

PLANT HOST SEQUENCE OF INSECTS

Figure 1 gives the common hosts of cotton insects and their most important periods as a host source. The dominant winter host in much of southern Arizona is London rocket, followed in the spring by wheat and barley, with alfalfa an important contributing reservoir to the overall insect populations. The major summer crops harboring the cotton insect pests and their associated predators are early and late-planted sorghum as well as the cotton, and with a heavy contribution from pig- or careless weed (Amaranthus spp.) late in the summer after germination is triggered by the summer thunderstorms.

London rocket is a major overwintering host of a number of insects associated with cotton. The weed germinates in late fall and grows during December, January, February, and March. In rainy seasons, the growing period may extend into April, but in dry seasons it may be curtailed. The weed grows in small patches to large acreages in all disturbed land, including

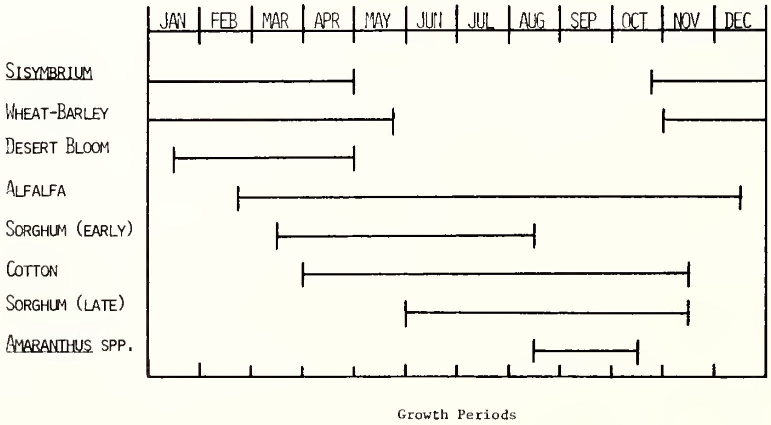

Figure 1.--Growth periods of major crop and weed reservoirs of insects associated with cotton in southern Arizona.

roadside ditches, irrigation canals, banks, and fallow fields. If the latter are not disked or plowed, the weed may cover large areas in discontinuous distributions. The weed is the host of the cabbage looper as well as several Lepidoptera specific to the London rocket. Other cotton pests present in fairly large numbers include Lygus spp. (as many as 23,000 per acre) and black fleahoppers (Spanogonicus albofasciatus (Reuter) and Rhinacloa forticornis (Reuter)). Thrips of several species are also found in large numbers. These, along with aphids, provide a food source for a large array of predators, including Collops spp., Hippodamia convergens Guérin-Méneville, Chrysopa carnea Stephens, and Orius spp. During the winter, small numbers of Geocoris spp. and Nabis spp. are also found on the London rocket.

With normal winter rains, the London rocket is followed by the globemallows (Sphaeralcea spp.) (16). Some globemallows grow in large clumps along the roadside and ditchbanks and harbor the same species that are found in the London rocket, including Lygus spp., the black fleahoppers, and attending predators and parasites. Stoner (16) has published an extensive list of the species taken from Sphaeralcea in southern Arizona. Other globemallows cover large areas of rangeland when the moisture conditions are proper and harbor low densities of pests and predators. However, the vast acreages of rangeland covered sparsely with the globemallows must be considered a major source of both pests and predators.

In the spring of 1968, alternate hosts were noted in a study of a lightly vegetated rangeland adjacent to cotton land near Stanfield, Ariz., but only small numbers of the common predators found in cotton were detected. The dominant plants in the area were Atriplex elegans (Moq.) D. Dietr. and Plantago insularis Eastw. Large numbers of a false chinch bug (Nysius prob. raphanus Howard), a frequent but innocuous inhabitant of cotton, were associated with these species. The most common predators were Orius spp. with a scattering of Hippodamia convergens, spiders, Nabis spp., Geocoris spp., and ants. The predators were commonly associated with the many aphids and heteropterous nymphs present on the plants. Chrysopa spp. larvae were found on a single creosote bush (Larrea tridentata (D.C.) Coville). Other species of plants were rare on the plot, with relatively large numbers of insects associated with the Sphaeralcea spp. where it occurred. Although the numbers of predators ranged from one to five per square yard, the vast areas of rangeland adjacent to cultivated areas may be considered a major source of predators when vegetation is triggered by sporadic rains.

Other spring weeds may locally harbor large numbers of both predators and pests. These weeds include cheeseweed (Malva parviflora L.), which generally grows in clumps similar to Sphaeralcea but may cover up to an acre of roadside ditch when moisture conditions are proper, and Erodium cicutarium (L.), L'Hér., a common, desirable desert forage plant.

MAJOR INSECT POPULATIONS

Populations of predators occurring concurrently with the spring weeds, but on wheat and barley, are presented in table 1. These populations generally peak during April when grain growth is at its maximum. However, if this period of maximum growth is extended into May, as in the 1973 data from Yuma (table 1), the greenbug (Schizaphis graminum (Rodani)) populations may continue to support large populations of attending predators such as Hippodamia convergens. With the maturation of the grain in late May, the aphid populations decline, and the predators are forced to move to a new food source.

Table 1.--Representative predator populations in southern Arizona in wheat and barley and in early and late-planted sorghum

		Mean monthly populations, in thousands per acre, of--						
County	Date	*Collops* spp.	*Hippodamia convergens*	*Nabis* spp.	*Geocoris* spp.	Other Hemiptera 1/	*Chrysopa* 2/	Spiders
				Wheat and Barley				
Pima	1972 Feb.	<0.1	0.3	0	0.1	<0.1	0.1	0.6
	Mar.	2.1	.9	.3	0	< .1	.5	.4
	Apr.	1.0	6.0	4.1	<.1	.3	<.1	1.2
Yuma	1973 Mar.	.0	1.4	.0	.3	.1	.0	.1
	Apr.	.0	7.8	.0	.6	.0	.2	.0
	May	.0	25.0	.5	3.3	.2	1.0	.6
				Early Sorghum				
Pima	1970 June	13.0	80.1	.7	2.5	1.7	30.3	1.1
	July	9.6	498.4	1.4	5.6	.9	26.4	16.4
	1971 June	2.3	66.5	.0	.0	.0	.0	.0
	July	3.4	35.9	2.4	1.1	.8	9.4	3.5
	1972 June	12.7	30.1	.6	.6	1.0	.2	1.4
	July	10.0	4.4	.6	.0	.4	.2	6.2
	Aug.	2.4	.6	.6	.0	.6	.6	4.8
	1973 June	1.0	65.4	1.0	.3	.9	3.2	2.4
	July	2.0	22.3	.1	.5	.7	.7	7.2
	Aug.	2.2	7.6	.2	0	.5	1.4	4.0
				Late Sorghum				
Pima	1970 July	17.9	29.2	.3	.9	.8	6.1	3.9
	Aug.	3.6	1.3	.0	.2	.3	2.6	10.2
	Sept.	.1	.2	.0	.0	.0	7.3	20.2
	1972 July	2.2	.4	.1	.1	.1	.1	.2
	Aug.	.8	6.3	<.1	<.1	<.1	1.9	1.7
	Sept.	.1	43.8	.0	.3	.7	19.1	7.3
	Oct.	.0	3.0	.0	.0	.2	8.7	3.4

1/ Orius spp., *Sinea* spp., *Zelus* spp.
2/ Adults.

If no food source is available nearby, the predator populations disperse over large areas. If early sorghum is grown nearby, biotype C of the greenbug may become the source of food for the moving predators. This biotype is tolerated in large numbers by sorghum plants without yield loss in Arizona. The data in table 1 for early sorghum in 1970, 1971, and 1973 demonstrate the potential of this food source to produce large numbers of predators within the early grain sorghum. The predators, with aphids as the major food, may attain a population in excess of a million per acre (5). Since most early sorghum varieties are relatively tolerant of the aphids, large populations may fail to have any marked effect upon the yield of grain. Therefore, an ideal nursery for large populations of predators exists. Fye (5), DeLoach and Peters (4), Robinson et al. (12), Fye and Carranza (7), and Burleigh et al. (2) have previously discussed the interchange of these predators between sorghum and cotton.

The data for 1972 (table 1) demonstrate the effects of suppressed populations of the greenbug that fail to support large populations of predators. Wood and Starks (17) have discussed this typical bioclimatic suppression of the greenbug by temperature and host. Therefore, climatic factors must be suitable for large populations of greenbugs if sorghum is to be an effective reservoir for the predators. Immediate harvest and stalk destruction are also essential to prevent late-season suckers, which will be attacked by the aphids. Thus, the predators remain associated with the sorghum aphids rather than moving to the adjacent crops.

During the early spring and into late May, alfalfa is also a major reservoir of pests and predators. In fact, figure 1 shows that during late May alfalfa is virtually the only crop occupied by both pests and predators. At this time, large populations of the pea aphid (*Acyrthosiphon pisum* (Harris)) supply large volumes of food for predator consumption, and the lush growth of the alfalfa provides a food source for such cotton pests as the bollworm (*Heliothis zea* (Boddie)) and the beet armyworm (*Spodoptera exigua* (Hübner)). The data from Pima County, presented in table 2, are representative of populations of predators that may be found in alfalfa during the season, and, in many cases, the populations may be higher than the densities presented in table 2. The data from Yuma indicate the suppression of predator populations that results from applications of insecticides for the alfalfa weevil (*Hypera brunneipennis* Boheman).

The Yuma field, noted in table 2, was sprayed for weevils in mid-March, and the predator populations failed to rebuild until mid- to late June. During July, the predators increased, but not to large populations, probably due to harvesting of the alfalfa for hay and a declining population of pea aphids. In both of the fields noted in table 2, large populations of *Lygus* spp. were present, and these apparently served as a major food source for the nabid populations, particularly in May 1972 and July 1973. The large populations of *Orius* spp., in the spring of 1972, were probably associated with thrips populations present in the alfalfa.

In general, alfalfa must be considered a major pest and predator reservoir. Of particular interest is *Lygus* spp., which can seriously damage cotton unless the populations of *Lygus* spp. are retained in the alfalfa-growing areas. A constant monitor of the insect situation in the alfalfa throughout the season may provide evidence of what can be expected in some cotton insect populations.

Table 2.--Representative predator populations in alfalfa in southern Arizona

			Thousands per acre of the following predators:						
County		Date	*Collops* spp.	*Hippodamia convergens*	*Nabis* spp.	*Geocoris* spp.	Hemiptera	*Chrysopa* adults	Spiders
Pima	1972	Feb.		0.4		0.2		0.4	0.1
		Mar.	2.6	2.1	2.1	2.5	2.8	.2	1.0
		Apr.	5.8	1.6	3.3	4.7	1.4	.2	1.0
		May	3.1	9.1	11.2	15.3	16.6	0	3.8
		June	4.7	5.4	2.3	17.2	10.2	0	6.8
		July	7.8	2.2	7.6	18.5	.1	.3	6.6
		Aug.	6.1	.9	.7	4.2	.5	0	2.3
		Nov.	.4	.4	.9	2.3	.9	2.6	4.7
Yuma	1973	Apr.	0	0	.7	0	4.4	0	0
		May	0	.7	1.3	1.1	1.8	0	.9
		June	.1	2.0	2.6	2.6	2.8	.4	1.3
		July	.4	2.0	6.1	5.2	2.0	.7	1.8

Representative detailed data on the occurrence of insects in cotton have been presented by Fye et al. (8), Bryan et al. (1), and many other sources. Generally, the predator populations increase from late June to early August, at which time a decline in the general predator populations occurs.

On Pigweed

In late summer, concurrent with the decline of the predator population in cotton, appreciable populations of both pests and predators develop in pigweed. Sweep samples taken in several years from this plant indicate adult populations in excess of 1,200 *Chrysopa* spp., 2,000 *Collops* spp., 1,700 *Nabis* spp., 4,500 *Geocoris* spp., and 8,500 *Orius* spp. in an acre of the weed. Pigweed is also a major source of pest species. In the sweep samples noted above, as many as 5,600 beet armyworms, 4,900 *Lygus* spp. adults, and 12,000 black fleahoppers per acre were detected. In addition, varying numbers of cabbage loopers and bollworms were present.

For example, the importance of pigweed was demonstrated in 1968 when the summer rains caused a flush of pigweed growth in late July and August near an isolated ranch near Red Rock, Ariz. A strip of pigweed, conservatively estimated as at least 20 ft wide growing along the roadways to the west, contributed about 6.7 acres of the weed on the western border of the ranch. A survey of the other three sides of the ranch indicated that at least 700 acres of the pigweed were within a 1-mile band on the north, east, and south sides. The pigweed was dense and lush when samples were taken, and the projected catches indicated an estimated population of at least 777,000 cabbage loopers in the pigweed alone. Many were in the late instars and could be expected to complete maturity. More than one-third of the collected larvae died from a polyhedral virus infection or were parasitized by *Copidosoma truncatellum* (Dalman). However, at least one-half million adults reared in the pigweed might have moved into the crops on the tilled land. Beet armyworms taken in the sweep samples indicated about 246,000 beet armyworms in the pigweed, but one-third of these were parasitized by Lespesia archippivora (Riley), and the estimate may be reduced to a conservative 150,000. Thus, if 1,000 acres of the tillable land were planted to fall lettuce, 500 cabbage loopers and 150 beet armyworm adults per acre were available for infestation of the fall lettuce.

The lepidopterous pests in pigweed are hosts for a large array of parasites, including a major parasite of the bollworm (Microplitis croceipes (Cresson)) (1). Therefore, although pigweed is a reservoir for several important pest species, it also serves as a reservoir for several beneficial species.

On Sorghum

The final major, seasonal source of insects associated with cotton is late-planted sorghum. Representative data on the populations of predators in late sorghum are presented in table 1. Generally, the populations of predators are much lower in the late sorghum than in the early sorghum. However, in the young late sorghum, populations of biotype C of the greenbug may be adequate to support fairly large populations of predators. During late July and early August, these populations generally decrease, but may increase again in September if planting of the late sorghum was delayed. However, the sorghum generally matures in September, and the aphid and attending predator populations do not regain maximum levels. The late sorghum also harbors large populations of bollworms, and, under suitable conditions, these may be heavily parasitized (8 to 24 percent) by M. croceipes. This fall bollworm generation serves as a principal host for the overwintering generation of parasite.

On Other Crops

As other crops are introduced into the complex, the movement of the predators and the pests will be complicated. For example, although large populations of predators may be present in the safflower, their effectiveness is negated by the damaging potential of large numbers of lygus bugs also present. Fall-grown corn may also be a major source of bollworms and fall armyworms (Spodoptera frugiperda (J. E. Smith)), and, unless the corn is harvested for green fodder or silage, the corn may serve as a major host of the overwintering population of these pests. The corn may also harbor large populations of predators that feed on the many softbodied insects associated with the late-season crop.

In general, lettuce is not considered in the sequence of crops harboring insects because of the heavy pesticide schedule applied to the crop. However, the fall-planted lettuce may be placed in jeopardy by the populations of bollworms, beet armyworms, and cabbage loopers associated with the pigweed and late sorghum, and, to some extent, uncontrolled cabbage looper populations in cotton. If these and other crops are involved in a local cropping sequence, studies will be necessary to determine the numbers and species of the pests and predators present so that they may be considered in the herding of the predators from one crop to the next.

CONCLUSIONS

If the estimates of insect populations noted in this report are accepted--with the reservation that the broad variance results in poor confidence intervals (11) for the mean population estimates, particularly those derived with sweep samples--it is evident that many reservoirs for both pests and predators are present in southern Arizona. The cropping and weed sequence presented is generally the basic pattern in southern Arizona, although, in many cases, the complexity is increased by the introduction of specialty crops. Although existent predators have not been utilized to the maximum, only minor manipulations may be necessary to improve the exploitation of these naturally occuring parasites and predators. In addition, alternate hosts outside of the cropping programs also harbor potential pests of cotton and other crops; thus, the manipulations must be performed so that the beneficial rather than the detrimental results will be achieved.

As the population dynamics of the various species of pests and predators are elaborated and the interrelationships of the species established, practical, feasible manipulations will become available for manipulation of the populations by grower-management programs.

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